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TIMBER PRESERVATION STANDARDS *

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Introductory Note

For this meeting the discussion is confined to considerations of conditions which obtain in developing countries and to preservatives most relevant to construction. This paper is also intended to be a lead to the group discussion on drafting a general code for use in developing countries.

There are two main problem areas in gaining widespread use and acceptance of timber preservation. The first is the technical problem of formulating satisfactory and realistic preservation standards for the various local hazards and timber species. The second much more difficult problem is ensuring that these and no other preservatives and methods are used. The two must go together and for preservation to be generally acceptable and satisfactory there must be enforceable and enforced regulations against the offering of timber as "treated" or "preservatised" and against the sale of non-approved chemicals as timber preservatives. Simultaneously, educational and promotional campaigns must be instituted and maintained at all levels - specifying professions, the timber and building industry down to the general public.

Specifications

In a developing country anxious to utilise more of its timber resource, one may find:

- a government owned railway sleeper and/or utility treating plant;
- one or more non-government pressure or diffusion plants;
- a range of Na-PCP or copper naphthenate solutions on sale as "wood preservative".

In formulating preservation standards and associated regulations, it is probably wisest to concentrate on the second, leave the first alone, and try and educate and regulate the third off the market. Government owned sleeper and pole plants are probably being operated fairly well and in any case theirs is a specialized product whose performance is unlikely to greatly affect other areas of timber construction.

Also such a body is unlikely to take kindly to being roped in to the construction industry with which it has little in common. However, if it is interested and enthusiastic over promoting preservation, well and good.

On the sale of penta etc. solutions, it may be argued that anything is better than nothing, but the situation should be watched and at the first indications of resistance to the purchase of properly treated timber on the grounds of its price compared with brush-on solutions, steps should be taken to remove them from the market in the public interst.

Scope of Specification

It is suggested that specifications should cover only waterborne preservatives of the CCA and boron types. These are capable of covering the whole range of preservation requirements for construction. Possibly insecticidal glueline treatment for plywood could be included (dieldrin, chlordane).

Other treatments are not included since in the opinion of the writer they have little relevance to the general requirements of a developing country.

Creosote and PCP in heavy fuel oil require expensive plant for application and their end uses are limited to sleepers, utility poles etc. If a creosote plant exists, then its operation is most likely covered by remarks in the above. Organic biocides in light oil are not very effective if applied only by dipping, although their use as a water repellent on already impregnated joinery is to be commended. With vacuum application of such preservatives (e.g. "Vascol") plant expense again becomes high, and penetration is limited unless a very light solvent is used in which case a major fire hazard exists at the plant.

One other process which might be considered is creosoting by the hot and cold bath process. This meets most of the requirements of technology in a developing country and in fact was recently recommended by the writer for installation in Madagascar as part of UNIDO prefabricated bridge process. (See Appendix 1).

The writer considers that the Preservation Treatment specifications of the Fiji Department of Forestry are a good model for use in other developing countries. They cover in sufficient detail the basic requirements for vacuum-pressure and diffusion treatments of a range of tropical and softwoods without being over-prolix and detailed.

The Fijian specifications will obviously require certain amendments. The lists of Fijian timbers in e.g. Section 3 and Section 5 would have to be replaced by appropriate local species. Some of the explanatory material might be considered as rather brief and the writer considers that the process specification for Bethel (Full Cell) vacuum-pressure treatment appended to the Papua New Guinea specifications should be included.

Another shortcoming is that the Fijian specification makes no mention of diffusion treatment with straight boron salts, e.g. borax-boric acid, "Timbor", etc. Boron does not give good protection against termites, at least not in reasonably attainable concentrations.

However, in core concentrations of 0.2% boric acid equivalent (BAE) it gives excellent protection against lyctid attack and at 0.1% BAE against anobid attack. The BFCA formulations in the Fijian specifications do give good termite protection due to their arsenic content and a comparison is given by Tamblyn et al (1) * which shows that the BFCA salts are comparable to CCA salts in this respect, and from 3 to 10 times as effective as borax-boric acid. However, C. R. Levy firmly believes in the deterrent effect of boron provided alternative wood is available (pers. comm), since termites will sometimes eat treated wood rather than starve.

The writer therefore believes that a straight boron salt process should also be included. Because of the large number of degrees of freedom in the operating parameters it is not possible to write a general process specification for boron diffusion but a few selected process specifications are given in the NZTPA Specification (2)* sections P6, P7 and P8 (Appendix 1). It should be made clear in a model specification that the process is not limited to these methods. For example in Sri Lanka effective boron treatment is achieved by overnight spraying of open stacked timber with a fairly weak solution followed by diffusion achieved in a covered fillet stack of rubber wood (Hevea Brasiliensis). Control

*See page 4

of wind velocity through the stacks is done by letting down rattan blinds. In this process the satisfactory diffusion is achieved through the high ambient temperatures and humidity and low wind velocity peculiar to the locality, and would not be possible in any other climate.

Regulations

Some form of enforceable regulations are required to ensure compliance with the specifications and to deter and if necessary punish unscrupulous operators. It is important that the regulations should be separate from the specifications. Legal and technical documents do not mix satisfactorily and making specifications part of a regulation inhibits technical progress.

The form and authority for these regulations must be a matter for local concern and no full model can usefully be offered. The NZ regulations are appended as an indication of what might be covered. The writer considers that the major points for consideration in these regulations are Clauses 2, 3(1), 3(3), 3(4), 8, 9(1), 9(2), 9(3), 10, 12 and 13(2). These form the core of the regulations and give them its teeth. It is interesting that although the regulations are administered in the NZ Forest Service they are actually made under the Board of Trade Act, and their enforcement then becomes a matter of commercial law.

References

1. Tamblyn, N., S.J. Colwell and G.N. Vickers, 1968, "Preservative Treatment of Tropical Building Timbers by a Dip-Diffusion Process", Ninth British Commonwealth Forestry Conference, Rentosol, London.

2. Timber Preservation Authority - Specifications N.Z. Forest Service, Private Bag, Wellington.

APPENDIX 1 *

Hot and Cold Bath Process—P1

The timber to be treated is placed in an open topped tank and completely submerged in the creosote or oil based preservative liquid, which is then heated to approximately 90-100°C. The actual time taken and temperature in this operation, relative to timber size and species and preservative liquid used, to be those which experience has shown to be adequate.

After the timber and the liquid have been heated, they are allowed to cool, or the hot liquid may be drained off and replaced by cooler liquid and the whole tank and contents allowed to cool to a suitable temperature. During treatment timber must be completely submerged and sufficient allowance must be made for uptake and additional preservative used so that no part of any timber will become exposed during treatment. Timber becoming exposed above the surface of the liquid at any stage of the process should be reimpregnated.

Process Specification P6

MOMENTARY IMMERSION (DIFFUSION) PROCESS

i.e., Open Tank
Spray tunnel
Chain dip
Hand dip

1. Preservatives

The following preservatives are approved for use with this process and are defined in Section F: Formulations:

Boron Compounds. (To be used in proportions to give solutions with the equivalent formulation of $Na_2B_8O_{13}$).

2. Commodities

This process may be used to treat produce as defined in commodity specification C8.

3. Moisture Content of Produce Before Treatment

Immediately before treatment, timber shall be in the green-off-saw condition.

4. Treatment (see also clause 7)

The material shall be treated in a plant as described in the introduction to this section (PP).

4.1 *Timbers up to 50mm in Thickness*—Timber shall be dipped or sprayed so that each surface of each individual piece is throughly wet with treating solution. Timber block-stacked for immersion is to be loosely tied or wired to permit the solution to thoroughly wet all surfaces.

4.2 *Timbers Over 50mm and up to 75mm in Thickness*

4.21 Open Tank

Either:

4.211 The timber to be immersed in fillet for 30 minutes; or

4.212 Timber block-stacked for immersion shall be immersed twice, the second immersion to take place between 2 and 4 days after the initial immersion. During the intervening period, the timber is to be covered with polythene or other approved drapes to prevent loss of moisture.

4.22 *Spray Tunnel, Chain Dip, and Hand Dip*—The timber is to be sprayed or immersed twice, the second immersion to take place between 2 and 4 days after the initial immersion. During the intervening period the timber is to be covered with polyethylene or other approved drapes to prevent loss of moisture.

* New Zealand Timber Preservation Association

4.3 *Rain-Wet Timber*—Rain-wet timber shall not be treated, and precautions shall be taken to ensure that after immersion timber does not become rain-wet while being conveyed to diffusion storage.

4.4 *Solution Concentration*

4.41 *Control*—The concentration of the treating solution shall be determined by analysis or from its specific gravity by reference to a chart (approved by the Authority) showing the relationship of concentration to specific gravity and temperature. The specific gravity of the sample of the solution shall be determined with a standardised hydrometer corrected for temperature. At least once in each calendar month of operating, an analysis of the solution shall be made by an analyst, or in a laboratory approved by the Authority.

4.42 The solution concentration, temperature, and diffusion time shall be as set out in the table at clause 7 below.

5. Measurement of Timber Quantity

Timber quantity shall be calculated from its nominal sawn dimensions.

6. Not applicable.

7. Minimum Operating Requirements

The standard minimum schedule of requirements set out below may, in special circumstances, be modified at the discretion of the Authority.

Species	Thickness	Open Tank		Spray Tunnel Chain Dip Hand Dip	
		Solution Concentration of H_3BO_3	Temperature	Solution Concentration of H_3BO_3	Temperature
	mm	percent	°C	percent	°C
Group A— Kahikatea Kauri	25	12	20	15	20
Pines— Muricata Maritime Ponderosa* Radiata Strobus Redwood	40 50 75	15 15 18†	20 20 25†	18 18 18†	25 25 25†

Species	Thickness	Open Tank		Spray Tunnel Chain Dip Hand Dip	
		Solution Concentration of H_3BO_3	Temperature	Solution Concentration of H_3BO_3	Temperature
	mm	percent	°C	percent	°C
Group B—					
Douglas fir	25	15	20	18	25
Pines—					
Slash	40	18	25	21	30
Corsican					
Loblolly	50	18	25	21	30
Totara					
Group Ba—	75	18†	25†	18†	25†
Larch					
Group C—	25	15	20	18	25
Matai	40	18	25	21	30
Miro					
Rimu	50	21	30	24	35
Tanekaha	75	18†	25†	18†	30†
Group D—					
Eucalyptus fastigata	25	30	35	35	50
Kohekohe					
Mangaeo					
Pukatea	40	35	50	40	55
Beech—					
Hard					
Red					
Silver	50	40	55	45	60
Hinau					
Rewarewa					
Taraire	60	30†	45†	30†	50†
Tawa					

*Diffusion time for 50mm as for Group Ba.

†Double dipping is required except for timber immersed for 30 minutes in the open tank in fillet.

8. Minimum Diffusion Periods

——	25mm	40mm	50mm	60mm	75mm
Groups A, B, C	4 weeks	6 weeks	8 weeks	-	16 weeks*
Group Ba	5 weeks	8 weeks	10 weeks	-	16 weeks*
Group D	6 weeks	9 weeks	12 weeks	16 weeks	-

*12 weeks for approved pine species.

9. Diffusion Storage

9.1 After immersion in the solution, timber shall be held under approved restricted drying conditions for a minimum period as shown in clause 8 above and until the concentration of boric acid equivalent of 0.1 percent for softwoods and 0.2 percent for hardwoods has been attained in the sapwood core as required by the commodity specification.

9.2 No timber shall be removed from diffusion storage prior to the completion of the full diffusion period under the control of the plant operator at the treating plant.

10. Not applicable.

Process Specification P7

STEAM AND COLD QUENCH (DIFFUSION) PROCESS

1. Preservatives

The following preservatives are approved for use with this process and are defined in Section F: Formulations:

Bolit
Boron compounds

2. Commodities

This process may be used to treat produce as defined in commodity specifications C5 (limited to battens in not more than 50mm x 40mm in section) and C8.

3. Moisture Content of Produce Before Treatment

3.1 *All approved Species EXCEPT Radiata pine*—Immediately before treatment, the timber shall be in the green-off-saw condition (i.e., in the high state of moisture normally found in freshly sawn timber).

3.2 *Radiata pine*—Radiata pine may be either in the green-off-saw condition or pre-dried to a moisture content not exceeding 25 percent.

4. Treatment

The material shall be treated in a plant as described in the introduction to this section (PP).

4.1 *Steaming*

4.11 *Building Timbers*—Timber shall be stacked with fillets between each layer of boards, transferred to the treatment chamber, steam heated to 82°C and maintained at this temperature for not less than 3 hours.

4.12 *Battens*—Battens shall be placed in the treatment chamber with horizontal fillets separating not more than 100mm of timber and vertical fillets separating not more than 250mm of timber, steam heated to 100°C and maintained at this temperature for not less than 6 hours.

4.2 *Draining Condensate*—At the completion of the steaming period, condensed water shall be drained from the treating chamber and the charge flooded with the treating solution immediately.

4.3 *Solution Concentration*

4.31 *Requirement*—For minimum solution concentrations see clause 7, Minimum Operating Requirements below.

4.32 *Control*—The concentration of the treating solution shall be determined by analysis between each charge and any necessary adjustment made. The solution shall be thoroughly mixed before sampling. At least once in each calendar month of operating an analysis of the solution shall be made by an analyst, or in a laboratory, approved by the Authority.

4.4 *Cold Quenching*—The cold treating solution shall be admitted to the chamber to a sufficient level to ensure that all pieces are wholly submerged for the duration of the quenching period. The minimum quenching period is defined in clause 7, Minimum Operating Requirements below.

5. Measurement of Timber Quantity

Timber quantity shall be calculated from its nominal sawn dimensions.

6. Not applicable.

7. Minimum Operating Requirements

The standard minimum schedule of requirements set out below may, in special circumstances, be modified at the discretion of the Authority.

7.1 *Boron Compounds* (Commodity Specification C8 only)

Species	Green-off-saw				Pre-dried to M.C. not exceeding 25 percent		
	Thickness	Solution Concentration of H_3BO_3	Immersion Time	Diffusion Time	Solution Concentration of H_3BO_3	Immersion Time	Diffusion Time
	mm	percent	hours	weeks	percent	hours	weeks
Radiata pine	25	1.5	15	2	1.5	15	—
	50	1.5	64	4	1.5	15	—
	75	N/A	N/A	N/A	1.5	60	—
Kahikatea Matai Rimu Miro	25	1.5	15	2	N/A	N/A	N/A
Tawa Hinau Mangeao Taraire Rewarewa	25	2.0	15	2	N/A	N/A	N/A
Kahikatea Matai Rimu	50	1.5	64	4	N/A	N/A	N/A
Tawa	50	2.5	64	6	N/A	N/A	N/A

7.2 *Bolit*

7.21 **Building Timbers** (commodity specification C8)
Species—Radiata pine up to 50mm thick and pre-dried to moisture content not exceeding 25 percent.
Minimum Solution Concentration—1.25 percent.
Immersion Time—Fifteen hours with a minimum temperature drop of 30°C.
Diffusion Time—Not applicable.

7.22 **Battens** (commodity specification C5)
Species—Radiata pine, Eucalyptus fastigata in 50mm x 40mm in section and in a green-off-saw condition.
Minimum Solution Concentration—Radiata 5 percent. Eucalyptus fastigata 6 percent.
Immersion Time—Six hours with a minimum temperature drop of 30°C.
Diffusion Time—Two weeks.

8. Diffusion Times

Diffusion times are set out in clause 7 above.

9. Diffusion Storage

9.1 After immersion in solutions of boron compounds or Bolit, timber shall be held under approved, restricted drying conditions for a minimum period as shown in clause 7 above and until the concentration of preservatives has been attained in the timber as required by the commodity specification.

9.2 No timber shall be removed from diffusion storage prior to the completion of the full diffusion period under the control of the plant operator at the treating plant.

10. Not applicable.

Process Specification P8

ACCELERATED BORON DIFFUSION PROCESS

1. Preservatives

The following preservatives are approved for use with this process and are defined in Section F: Formulations:

Boron Compounds

2. Commodities

This process may be used to treat produce as defined in commodity specification C8.

3. Moisture content of Produce before Treatment

Immediately before treatment, the timber shall be in the green-off-saw condition.

4. Treatment

The timber to be treated shall be placed in a suitable vessel and covered completely with treating solution. The temperature of the solution shall be raised to 90°-95°C and held for the length of time stipulated in clause 7. The time may be calculated from when 90°C is reached but at least two-thirds of the total time must be not less than 93°C. The solution shall then be allowed to cool, or be replaced with cold solution, and held for the time stipulated in clause 7 or longer if necessary until the solution temperature is below 50°C. The timber shall then be held in diffusion storage at elevated temperatures as detailed in clauses 8 and 9.

5. Measurement of Timber Quantity

Timber quantity shall be calculated from its nominal sawn dimensions.

6. Not applicable.

7. Minimum Operating Requirements

7.1 *Species and Sizes*—The process may be used for timbers up to 50 mm thick of the following species: radiata pine, tawa, rimu, totara, kahikatea, kauri.

7.2 *Spacers*—Spacers of at least 10 mm thickness shall be used between every fourth tier for timber up to 25 mm thick and every second tier for timber of greater thickness.

7.3 *Duration of Hot Bath*—The hot bath, as defined in clause 4,

shall be maintained for 3½ minutes per millimetre of board thickness (times to be taken to the nearest 10 minutes).

7.4 *Duration of Cold Bath*—The cold bath duration shall be the same as for the hot bath, or longer if necessary for the final temperature to be less than 50°C.

7.5 *Solution Concentration*—The minimum solution concentration shall be 8.5 calculated as boric acid (H_3BO_3) equivalent. Solution concentration should be checked by titration after every topping-up operation.

7.6 *Specified departures from Standard Schedules.* Any departures from the standard schedules for individual plants, species, or sizes shall be at the discretion of the Timber Preservation Authority.

8. Minimum Diffusion Period

Diffusion may be carried out at temperatures of 50°C or 70°C.

The minimum diffusion period for timber held at 50°C shall be 3½ days for every 25 mm thickness and for timber held at 70°C shall be 2 days for every 25 mm thickness. (Times to be taken to the nearest half day.)

Any departures from the standard minimum diffusion periods shall be at the discretion of the Timber Preservation Authority.

9. Diffusion Storage

Diffusion storage shall be carried out in an enclosed building or vessel in which the relative humidity will be maintained at not less than 95 percent. The temperature shall be controlled by a thermostat to within ± 2°C of the specified diffusion temperature.

10. Not applicable.

APPENDIX 2

Process Specifications for Treatment of Timber by Vacuum/Pressure Impregnation

Introductory Note:

Because of very fundamental difference between the structure of hard-woods (Angiosperms) and soft-woods (Gymnosperms) especially in the size and distribution of fibres or fibre tracheids, rays and axial parenchyma and large void space associated with vessels in hardwoods, the treatment schedules used for conifers may give quite unsatisfactory results for hardwoods. Thus in conifers, fibre tracheids, the strength giving elements, make up some 90% of the total wood volume, with parenchyma and resin canals making up the remainder. In temperate conifers the major differences are between early wood and late wood and of course sap and true wood.

In a permeable softwood, the gross retention obtained usually gives a fair estimate of the retention in the fibre - tracheids. However, in a hardwood, the gross retention is dominated by the retention in the vessels and parenchyma and is likely to be unrelated to the retention in the fibres, the main strength giving elements. In many hardwoods significant penetration of fibre lumen may not even start until all the vessels and parenchyma lumen (void space) have been filled with preservative and this may require about 80% total preservative solution. In the worst cases we thus use up to 80% of the total preservative before we start to treat the fibres towards the end of the treatment cycle. It may be true that the final 1% or so of the total preservative uptake is what finally gives what protection against soft-rot fungi that is obtained and so the final stages of treatment take on special importance.

The standard procedure in specifying the final stage of treatment is to set a final rate of flow which, in this standard, is the uptake of preservative in litres per cubic meter of charge volume in a ten minute period. That treatment of each charge reaches the final rate of flow is a critical factor in meeting this standard and all treatment plants should be kept in a good state of repair, free from leaking valves and door seals so that this final rate of flow may be determined accurately.

Becuase the rate of uptake and final retention obtained varies greatly between timber species, only those timbers listed in similar retention groups shall be treated together in the same charge and then all pieces should be of similar cross sectional area and length.

Process Specifications

Bethell (Full Cell) Vacuum Pressure Process

1. Application. The treatment of all timber, either round or sawn for utilization classes U2, U3, U4, U5 and U6 shall be by the Bethell (Full Cell) Vacuum Pressure Process as described in this Appendix.

2. Retention Groups. In Schedule 2 of this standard 12 retention groups are listed. Timber species within each retention group may be treated in the same charge provided that all pieces in the charge are intended for the same end use and have the same form.

Thus charges shall not consist of both natural rounds and sawn timber, or of fence posts and utility poles and etc.

3. Preservative Solution Strength. In Schedule 2 of this Standard, recommended preservative solution strengths of a high copper and a low copper preservative are listed for each timber species according to its utilization class.

4. Treatment of Mixed Charges. When a charge consists of more than one timber species within a utilization class/retention group, the solution strength used shall be the highest for timber species in that charge.

5. Hydraulic Pressure. Where a mixed charge is being trated and this Standard requires that one of the timber species in that charge will be treated at 2100 kPa, the whole charge will be treated at 2100 kPa.

6. Non Availability of plant capable of reaching 2100 kPa hydraulic pressure

When the v/pressure cylinder is for use at 1400 kPa or lower and it is desired to treat a timber species for which a hydraulic pressure of 2100 kPa is specified in this standard, the final rate of flow specified in this standard for the timber species/utilization class must be reached and the maximum hydraulic pressure available maintained for an additional hour.

7. Treatment Schedule.

7.1 Initial Vacuum. An initial vacuum of at least 50 mm of mercury absolute shall be drawn and maintained for at least 45 minutes and any further period required so that during the pressure stage, the time taken to reach a hydraulic pressure of 1300 kPa shall not exceed 15 minutes.

7.2 Pressure. The working pressure shall be as set out in Table 2.1 below, and shall at no time be more than 100 kPa less than that specified.

Utilization Class	Working Pressure				
	Note 1		Note 2		Note 3
U2	340 kPa	or	1400 kPa	or	2100 kPa
U2	340 kPa	or	"	or	"
U3	340 kPa	or	"	or	"
U4	340 kPa	or	"	or	"

Note 1. Where prior to the publication of this standard, treatment plants for use at hydraulic pressure of at least 340 kPa (50 Psi) were in operation, these plansts may be used for treatment of timber for utilization classes U2, U3 and U4 provided that this standard does not call for working pressure of 2100 kPa for the timber species being treated.

Note 2. Further to paragraph 6 of this Appendix where a working pressure of 2100 kPa is specified and a treatment plant in operation at the time of publication of this Standard, is rated at 1400 kPa, these timber species may be treated provided that after reading the specified final rate of flow the pressure is maintained for one further hour.

However, in any treatment plant installed subsequent to the publication of this Standard, the specified working pressure must be used.

Note 3. A working pressure of 2100 kPa rather than 1400 kPa has been specified for those timber species in which significant additional uptake of and/or improved distribution of preservative can be obtained.

FINAL RATE OF FLOW IN LITRES PER 10 MINUTES PER CUBIC METER

RETENTION GROUP

Utilisation Class		1	2	3	4	5	6	7	8	9	10	11	12
U1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
U2		14	14	14	13	12	12	10	8	8	8	6	3
U3		14	14	14	13	12	12	10	8	8	8	6	3
U4	Round	7	7	7	6	6	6	5	4	3	3	3	1.5
U4	Sawn	14	14	15	6	6	6	5	4	3	3	3	1.5
U5	Round	3.5	3.5	3.5	3	3	3	2	2	1.5	1.5	1.0	0.5
U5	Sawn	7	7	7	3	3	3	2	2	1.5	1.0	1.0	0.5
U6	Round	7	7	7	3	3	3	2	2	1.5	1.0	1.0	0.5
U6	Sawn	7	7	7	3	3	3	2	2	1.5	1.0	1.0	0.5

Note I Final rates of flow herein are based on total charge volumes

Note 2 These final rates of flow are subject to change when so indicated by the PNG WPA.